Complete excision of the wound is accomplished by beginning at one edge, removing approximately ⅛ of an inch in thickness across its base, including ⅛ of an inch of the skin border on the opposite side, but sparing tendons, blood vessels, and nerves. The ends of the injured nerves and tendons are cut off sharply, and soiled portions of bone are removed by means of a chisel or gouge. By this procedure, all the iodine is completely and systematically removed, as well as all particles of dirt and devitalized tissue. The potentially-infected wound thus becomes more nearly aseptic, and more nearly free of irritating chemicals. All remaining structure are potentially viable. After such an excision of the wound is accomplished, the instruments used are discarded and fresh drapes are applied. A new set of sterilized instruments is then brought into use.

Before removing the tourniquet, all structures that need repair, such as tendons and nerves, should be identified. After its removal the wound is covered with sterile gauze and manually compressed; bleeders are identified and tied off with triple "O" catgut, following which the operator is free to complete the suturing of all severed structures. Before describing this technique, it should be stated that nerves, bones, and joints should be covered, since these structures do not remain viable if left exposed. Skin flaps from adjacent areas may be utilized. Defects resulting from the transposition of these flaps may then be filled in with Thiersch skin grafts.

TENDON SUTURES

The ends of severed extensor tendons can, in most instances, best be approximated by means of No. 35 stainless steel wire, as advocated by Bunnell.[2] The double figure-of-eight suture is used, and the skin borders overlying the tendon are approximated by the continuation of this suture in the form of a mattress stitch through the skin. The skin borders of the remaining portion of the surgical incision are then approximated by intermittent mattress sutures of silk supported by a continuous running suture of No. 35 stainless steel wire. The use of stainless steel wire has been noted consistently to provide very little or no reaction, as compared to other materials. Sulfanilamide may be implanted in the wound before closure. Either tetanus toxoid or tetanus antitoxin is administered in all such injuries.

The flexor tendons, when severed, yield the poorest result, since they are enclosed in a tunnel-like sheath. Because of the firmness of this tunnel, the swelling following surgery impairs the blood supply and the structures may subsequently become ischemic or necrotic. The tendon may also become fixed by a firm scar, resulting in a stiff finger and loss of function. For this reason the sheath should be divided on its lateral surface. It is also preferable to use a suture material which produces the least reaction, as well as to approximate the severed tendon ends with as simple a stitch as possible.

Where flexor tendons of the fingers and hand are severed at the same level, it may be advisable to remove the flexor sublimus tendon, and suture only the flexor profundus. The latter can be accomplished by means of placing a wire suture through the proximal and distal portions of the tendon. This suture, in turn, is brought out through the tendon sheath and the skin at a point distal to the site of severance, and fixed by tying the knot over a small piece of rubber tubing, or to the nail of the involved digit. The pull-out wire passed through the proximal loop of the suture is brought out through the tendon sheath and skin. Likewise, this suture is fixed by tying it over a small piece of gauze, or rubber tubing, proximal to the site of repair. These sutures remain in place for a period of three to four weeks. If a pull-out wire is used, the entire suture can be removed from the tendon, after healing takes place. Should infection interrupt healing, the suture can be removed at any time. If stainless steel wire is not available, standard methods of suture can be carried out utilizing Deknatal No. 2 silk. If only the sublimus tendon is severed, it need not be sutured, since it is not essential for good function and only serves to balance the flexor mechanism of the finger.

NERVE REPAIR

Nerves are sutured with fine silk, using a small, straight needle. The severed ends are approximated by means of interrupted fine sutures taken at regular intervals about the circumference of the nerve sheath. Passing sutures through the nerve substance is avoided, and the approximated ends should never be under tension.

After completing the treatment of the wound in all its manifestations, it is advisable to elevate the injured extremity by means of an aeroplane splint until acute swelling has subsided. This relieves compression of tissue, especially nerves and blood vessels, by gravity edema. It also decreases pain and hastens recovery.

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HAND FRACTURES IN INDUSTRY*

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THE HAND, a tremendously important organ to any workman, is subject to a high incidence of injury, and deserves a great proportion of industrial medical attention. Because of the extreme importance that all possible function be restored after an injury to the hand, even small and apparently insignificant injuries must be respected, and receive careful and intelligent care. Lacerations and contused wounds, even though apparently minimal in extent, may communicate with tendon sheaths, joint spaces, or closed compartments which have poor tissue resistance to infection, but infections of which may lead to severe disability. Early definitive care is imperative, and should include immaculate cleansing with soap and water, thorough debridement, local sulfonamide application, closure without drainage, and adequate immobilization.

Fractures of the skeletal structures of the hand present a particularly serious problem, since they may lead not only to deformity of the bony structure, but their close proximity to tendons and joints may markedly limit the function of these structures as well.

FRACTURES OF THE TERMINAL PHALANGES

Fractures of the terminal phalanges occur more frequently than fractures of any other bones of the body. Fortunately, there is little tendency toward separation of the fragments, and disability from this injury is rare. Immobilization for two weeks by a protective metal finger splint will usually be sufficient. Compounded fractures of the terminal phalanges may shatter the bone and the removal of separated fragments should be in-

* One of several papers in a Symposium on "Industrial Medicine in Wartime—the Widening Field of Industrial Medicine." Papers collected by Rutherford T. Johnstone, M. D.

cluded in the debridement. Removal of sufficient bone to allow a well-padded, soft-tissue flap on the end of the bone is far superior to attempts at skin grafting. It is frequently advisable to remove the proximal third of the nail in compound injuries involving this region. This procedure allows free drainage of infection about the eponychium, decompresses painful subungual hematomata, and may result in a smoother second-nail growth.

A special problem of the terminal phalanges is the so-called baseball fracture, or avulsion, of the extensor tendon with displacement of a chip from the articular surface of the terminal phalanx. Usually the extensor tendon does not retract and immediate fixation in plaster, maintaining the distal joint in hyperextension and the proximal interphalangeal joint in flexion for six weeks, is the treatment of choice. The results of those injuries which include a chip fracture are, as a rule, much better than those consisting of tendon avulsion only. The results from open reduction are less favorable than those with closed treatment, instituted early.

FRACTURES OF THE MIDDLE AND PROXIMAL PHALANGES

The displacement of the fragments following fractures in these regions may require immobilization with the finger in either flexion or extension, as dictated by x-ray appearance. In general, fractures distal to the middle of the shafts of those bones will require fixation in flexion.

Skeletal traction is usually indicated in comminuted or compounded fractures of these bones, and should be applied in line with the desired position of the finger.

Compounded fractures of these regions present the poorest end results of this entire group of fractures, because of tendon adhesions and joint fixations. Immobilization time should be minimum, and active motion can usually be instituted within two to four weeks.

FRACTURES OF THE METACARPALS

The first metacarpal is frequently fractured near its base and may be of two general types. The transverse, impacted type, not involving the carpal-metacarpal joint, does not require traction, and simple correction of the adduction deformity by disimpaction and abduction is sufficient. Those fractures of the base of the first metacarpal, extending obliquely into the joint, are unstable, usually shortened and require skeletal traction for about four weeks.

Fractures of the metacarpal shafts usually result in dorsal angulation, because of the stronger pull of the flexor muscles, and should be maintained in well-moulded plaster, incorporating at least the neighboring fingers. The fingers themselves may be in partial flexion, but should be supported by the cast, which fits firmly beneath the metacarpal heads. These fractures are prone to be oblique and to shorten, and again skeletal traction should be applied and maintained to overcome all overriding.

Fractures at the neck of the metacarpal often present a difficult problem. Impaction should be broken up and padded pressure applied within the cast. Acute flexion of the finger, and upward pressure in line with the proximal phalanx, may obtain a reduction otherwise impossible to achieve. The metacarpo-phalangeal joint is especially vulnerable to puncture wounds, which require immediate and adequate debridement.

IN CONCLUSION

In general, emphasis should be placed upon the following:

(1) Early definitive care of fractures of the hand to a point that they are considered a surgical emergency.

(2) Accurate reduction, and traction when necessary.

(3) The use of nonpadded, well-moulded plaster casts which obtain maximum immobilization of the fragments, and yet allow maximum function and use of the noninjured portions of the extremity. Use of the uninvolved portions of the hand during immobilization should be encouraged, for it will greatly speed recovery and lessen disability resulting from fractures of the hand.

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TREATMENT OF INDUSTRIAL EYE INJURIES*

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THE prerequisites to good industrial ophthalmology are good light, good vision, and good instruments. Each emergency unit should have a separate cubicle for eye-cases. In this space there should be good light, a binocular loupe, a few drugs, including an anaesthetic, such as pontocaine or butyn, also mercurochrome (one per cent) and a solution of boric acid; a sharp-pointed and a dull spud, and alcohol (seventy per cent) for sterilizing instruments. I feel that argyrol should not be on this list, as it is too often confused with tincture of iodine. Yellow oxide of mercury is irritating. The use of mydriatics, except in extreme cases, should be left to the judgment of the ophthalmologist.

Foreign bodies of the cornea should be treated with great respect. Those in the center should be referred to an ophthalmologist, as bad results are costly in man-hours, and large permanent disability ratings. Those at the limbus do not justify such great care. Give the anaesthetic time to work, and the patient will be more coöperative. If the foreign body is superficial, attempt to remove it with a tightly-wrapped, moist cotton applicator. If unsuccessful, use your spud, follow with a drop of mercurochrome, which not only stains and may show other wounds or foreign bodies, but also acts as a germicide. Inspect the everted lid of the injured eye, and also examine the opposite eye. Apply a pad for an hour or two, as, according to Behrens, the lachrymal secretion is an effective germicide. Instruct the patient to return the same day, if irritation continues, and also to return the next day for observation and a rating of vision if the eye is in good condition.

Every red eye seen is not necessarily an injured eye or a conjunctivitis. Conjunctivitis usually shows redness, swelling, and discharge. Iritis and glaucoma also cause redness in the eye, but no discharge. These two conditions are too often treated as a simple conjunctivitis, until visual damage has been done. Severe pain indicates a deeper inflammation; wherefore, if not sure of your diagnosis, refer the case to an ophthalmologist. A conjunctivitis usually responds rapidly to treatment.

Kerato-conjunctivitis is difficult to diagnose in the early stages. The patient usually has a tearing, red eye, with the sensation of a foreign body or an arc burn. Eventually, follicles appear in the lower cul-de-sac. There may be a slight rise in temperature; later on, swelling and tenderness of the preauricular glands on the affected side.

Flash burns always involve both eyes, and usually the symptoms do not appear for several hours after exposure, with photophobia, tearing and sensation of sand in the eyes. Treatment is a mild anesthetic, combined with adrenalin or other vasoconstrictor, cold compresses and protection from light. The discomfort lasts only a few hours.

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